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METHODS FOR DETERMINING THE SPECIFIC GRAVITY OF WOOD FOR AIRPLANE USE

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METHODS FOR DETERMINING THE SPECIFIC GRAVITY OF WOOD FOR AIRPLANE USE[1]

The specific gravity or density of wood, exclusive of the moisture it contains, affords a good indication of the strength properties. Hence, in the absence of actual strength tests to establish the quality of individual pieces of wood for highly-stressed parts, such as spars, a minimum specific gravity requirement has been established for each species.

There are several methods of expressing the specific gravity of wood, but that used in aircraft inspection is the specific gravity based on the weight and the volume when oven dry.

Either of the two methods described below is suggested for determining the specific gravity based on weight and volume when oven dry. The second method should be used only when the apparatus essential to the first method is not available.

First Method (Immersion Method)

Selection and Preparation of Test Specimen

At least one specimen should be cut from each piece of stock to be examined. A convenient form of specimen is a section 1 to 2 inches in length (direction of the grain) taken from a board, plank, or part. The volume of the specimen should preferably not be less than 5 cubic inches[2] nor more than 25 cubic inches. The object of limiting the length of the test specimen in the direction of the grain is to reduce the time required for drying. For the determination of specific gravity by this first method, the specimen need not be regular in shape. All loose splinters should be removed.

Determination of Specific Gravity

After selecting a representative test specimen, proceed as follows:

1) Put the specimen in an oven at 212° F. (100° C.) and dry until the contained moisture is evaporated and the weight becomes constant. This will require from 1 to 2 days. If a number of specimens are placed in the oven for drying at the same time, they should be open-piled to allow free access of air to all surfaces of each piece.

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[1]This mimeograph is one of a series of progress reports issued by the Forest Products Laboratory to aid the Nation's defense effort.

[2]Satisfactory specific gravity determinations can be made on specimens less than 5 cubic inches in volume by using a suitably sensitive balance such as that shown in figure 2. Greater precision in technique is required with very small than with large specimens to insure a given standard of accuracy.

2) Weigh the oven-dry specimen while warm. It is most convenient to record the weight in metric units (grams and decimals thereof).

3) Determine the volume by the immersion method after moisture-proofing the specimen, as follows:

(a) After the oven-dry weight has been obtained, dip the specimen, preferably while still warm, in hot paraffin. With good technique no surplus paraffin should adhere to the sample, but in the event that it does, any surplus should be scraped off.

(b) Find the volume of the specimen by determining the weight of water it displaces when immersed.

A container holding sufficient water for the complete submersion of the specimen is placed on one pan of a balance. The container and water are then balanced with weights added to the other pan. By means of a sharp pointed rod or other grip, the specimen is held completely submerged and not touching the container while the scales are again balanced. (fig. 1). The additional weight required to restore balance is the weight of water displaced by the specimen, and, if in grams, is numerically equal to the oven-dry volume of the specimen in cubic centimeters.

It is important that the determination of the volume by weighing be made as quickly as possible after the immersion of the specimen, since any absorption of water by the specimen directly influences the accuracy of the result. By estimating the volume of the specimen and placing on the pan approximately the required weights before the specimen is immersed, the time necessary for balancing may be reduced to a minimum.

The rod or grip by means of which the specimen is held in position should be as small as practicable. Care should be taken not to lower the specimen into the water to a much greater depth than required to submerge it completely; otherwise, the weight of the water displaced by the rod or grip may increase appreciably the weight required to balance, and hence may seriously impair the accuracy of the result.

4) Compute the specific gravity from the equation, specific gravity $= \frac{D}{V}$, where D is the oven-dry weight of the specimen in grams, and V is the oven-dry volume of the specimen in cubic centimeters. When the weight as obtained under paragraph 2, and the volume as obtained under paragraph 3 are in metric units as suggested, the values may be substituted directly in the formula above. (See example).

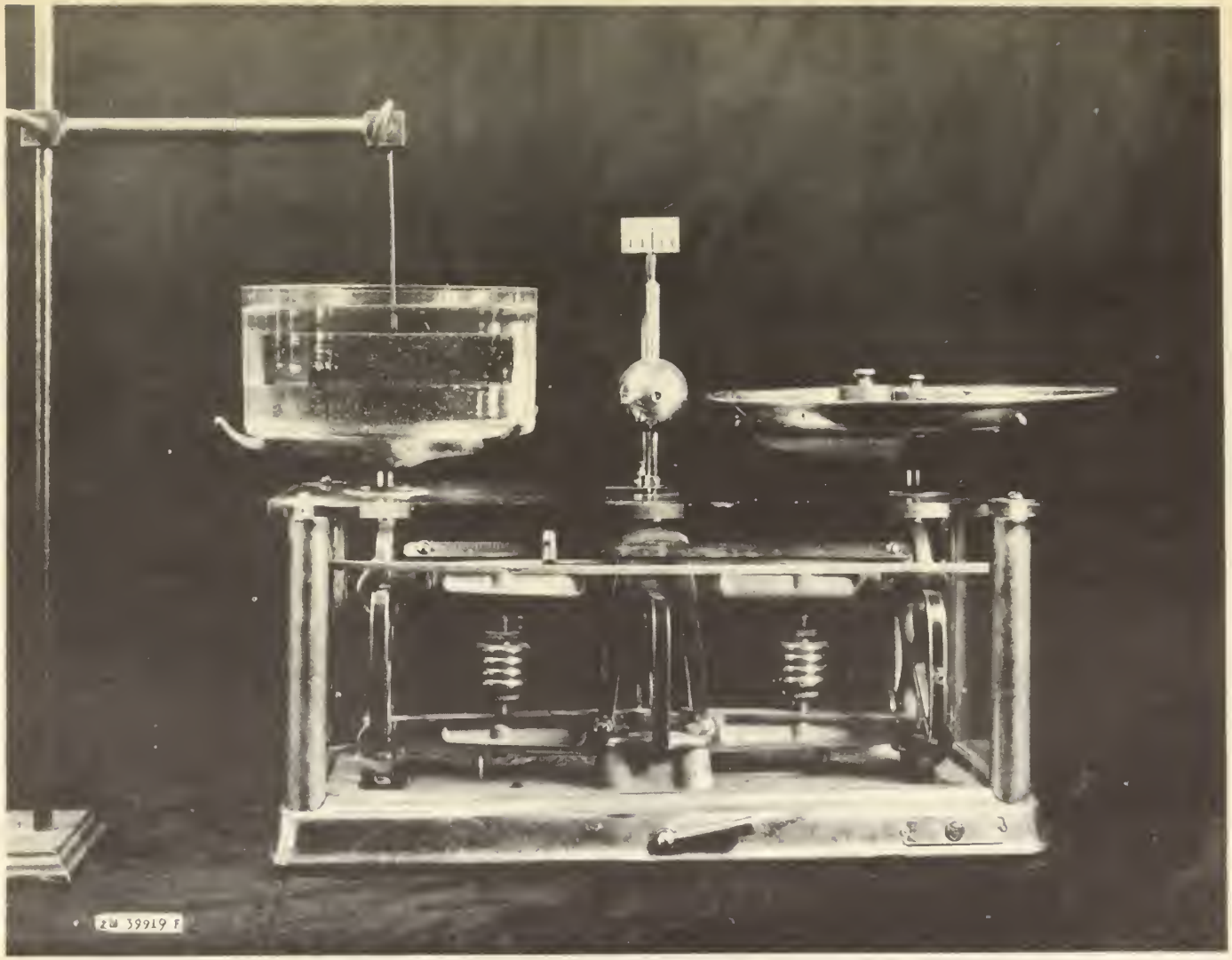

Figure 1.--Apparatus for determining the volume of a wood specimen. This is accomplished by immersing the specimen by means of a sharp pointed rod or other grip, and weighing the buoyant force of water displaced. If the units are in grams, the weight required to restore balance is numerically equal to the volume of the specimen expressed in cubic centimeters.

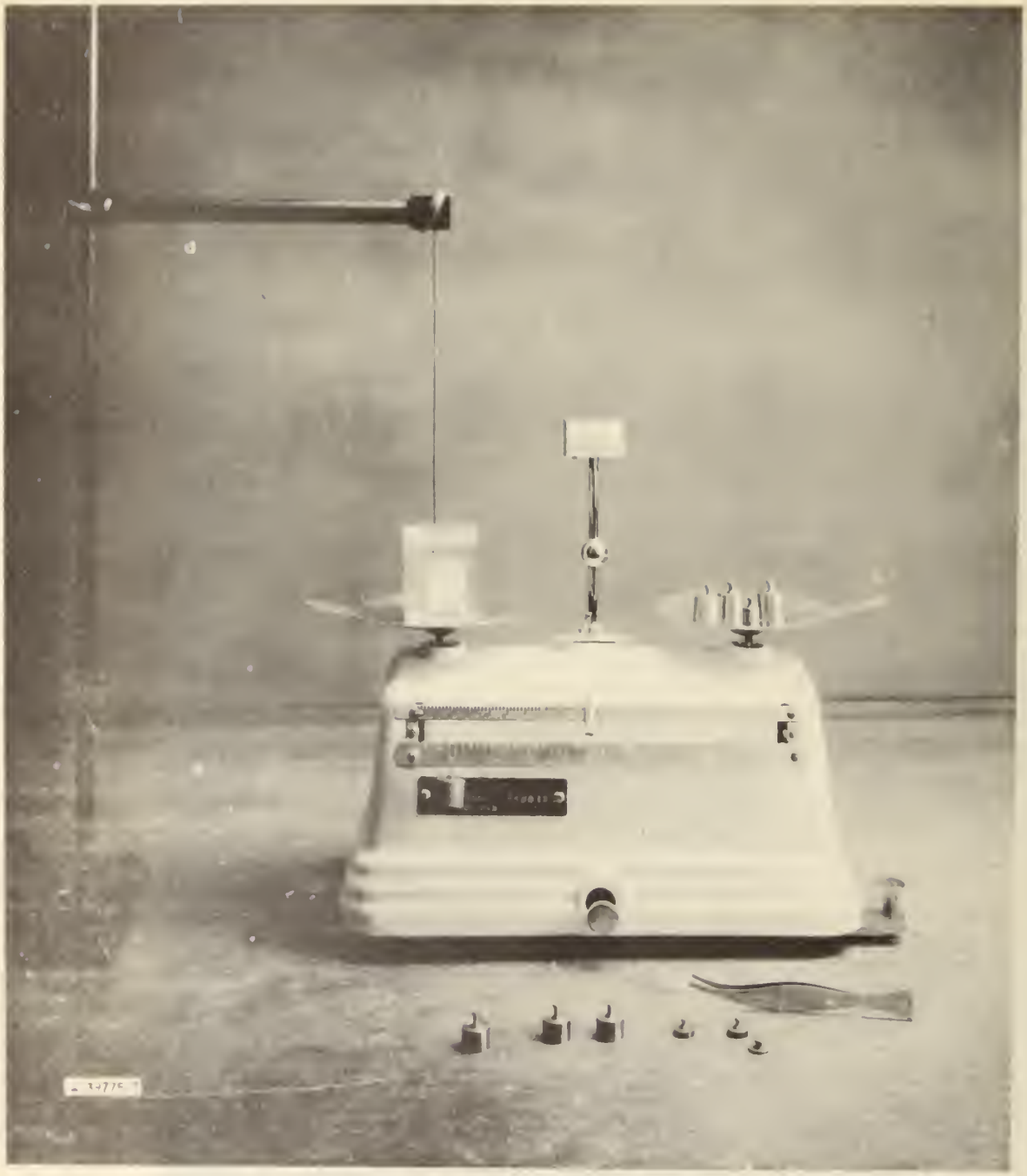

Figure 2.--Satisfactory specific gravity determinations can be made on specimens less than 5 cubic inches in volume provided a suitably sensitive balance, such as shown here, is employed.

Second Method (Measurement Method)

The second method differs from the first in that the volume is determined by measuring the specimen, rather than by immersing it in water.

Selection and Preparation of Test Specimen

The general instructions for the selection of test specimens as described for the first method should be followed with the additional requirement that the specimens be regular in shape. The cross section should hence be square or rectangular, and the ends should be parallel.

After selecting a representative test specimen, proceed as follows:

1) Put the specimen in an oven at 212° F. (100 ° C.) and dry until the contained moisture is evaporated and the weight becomes constant.

2) Weigh each standard oven-dried specimen while warm. It is most convenient to record the weight in metric units. If the specimen becomes out of shape in drying to a degree that the volume cannot be determined accurately by measurements, it should again be cut to regular shape before weighing.

3) Carefully measure the width, height, and length of each oven-dried specimen, taking average measurements when this appears desirable. From these compute the volume of the specimen. If the volume is determined in English units, it may be converted to metric units by the conversion factors below.

4) Compute the specific gravity from the equation specific gravity = $\frac{D}{V}$, where D is the oven-dry weight of the specimen in grams, and V is the volume in cubic centimeters.

General Information

Conversion Factors

In computing specific gravity by the above formula, all measurements must be expressed in metric units. When any of the measurements are expressed in English units, the conversion factors given below may be used:

1 inch	= 2.54 centimeters
1 cubic inch	= 16.4 cubic centimeters
1 ounce	= 28.4 grams
1 pound	= 453.6 grams

Accuracy

In order to insure good results, the weights and volumes by either method should be obtained to an accuracy of at least one-half of 1 percent.

Moisture Content

The moisture content of the specimen is usually obtained along with the specific gravity. The only additional step is to obtain the weight of the specimen immediately after sawing. It is important that the weight be taken immediately after sawing, since wood is subject to moisture changes on exposure to the air. The degree and rapidity of change are dependent on the moisture content of the piece and the condition of the air to which it is exposed.

The percentage moisture content of the wood from which a test specimen is cut is expressed by the formula

$$\text{Moisture content, in percent} = \frac{W - D}{D} \times 100$$

where

W = original weight of the specimen before drying
D = oven-dry weight of the specimen.

Example 1

Calculate the specific gravity, based on weight and volume when oven dry, of a sample of Sitka spruce on which the following data have been obtained by the first method discussed.

Weight when oven dry (par. 2) = 57.4 grams

Volume (weight in grams required to balance after immersing specimen) (par. 3) = 140.7 cu. cm.

$$\text{Specific gravity} = \frac{D}{V} = \frac{57.4}{140.7} = 0.41$$

Example 2

Calculate the specific gravity, based on weight and volume when oven dry, of a sample of Sitka spruce on which the following data have been obtained by the second method described.

Weight when oven dry (par. 2) = 57.4 grams

Measurements when removed from oven (par. 3):

Ave. length = 1.08 inches
Ave. width = 2.47 "
Ave. thickness = 3.27 "
Volume in cu. cm. =
1.08 x 2.47 x 3.27 x 16.4 = 143.0 cu. cm.

$$\text{Specific gravity} = \frac{D}{V} = \frac{57.4}{143.0} = 0.40$$

Example 3

Calculate the specific gravity, based on weight and volume when oven dry, of a sample of Sitka spruce of less than 5 cubic inches on which the following data have been obtained by the first method described.

Weight when oven dry (par. 2) = 5.89 grams
Volume (weight in grams required to balance after immersing specimen) (par. 3) = 13.29 cu. cm.

$$\text{Specific gravity} = \frac{D}{V} = \frac{5.89}{13.29} = 0.44$$

Example 4

Calculate the moisture content of the sample of Sitka spruce used in Example 1. The weight of the sample, immediately after sawing, was found to be 63.9 grams.

Weight when oven dry = 57.4 grams

$$\text{Moisture content, in percent} = \frac{W - D}{D} \times 100 = \frac{63.9 - 57.4}{57.4} \times 100 = 11.3$$

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